Surgical radiofrequency ablation for atrial fibrillation: the Christchurch, New Zealand experience

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Abstract

Aims To report the long-term results following surgical radiofrequency ablation (RFA) for atrial fibrillation as an adjunct to other cardiac surgery at Christchurch Hospital.

Methods A retrospective observational audit review of outcomes. The sample population included all patients identified as having undergone surgical RFA for atrial fibrillation at Christchurch Hospital, between the first procedure performed on 2 July 2001 and 28 January 2009.

Results A total of 44 patients underwent surgical RFA between 2 July 2001 and 28 January 2009. Postoperatively there were three deaths prior to discharge (7%). Pacemakers were required in four patients (9%), and two patients subsequently underwent catheter ablation for atrial arrhythmias. In the immediate postoperative period only three patients remained in atrial fibrillation. At last follow-up up to 102 months from surgery (45±29 months), 27 patients had developed persistent atrial fibrillation and four persistent atrial flutter. Persisting long-term benefit was seen in seven patients (18%, 7/38); five patients were in stable sinus rhythm, one had paroxysmal atrial fibrillation and one paroxysmal atrial flutter.

Conclusions Whilst the procedure was effectively acutely, the recurrence of atrial fibrillation was high and development of new atrial flutter common over long-term follow-up.

Treatment for atrial fibrillation and atrial flutter has traditionally focused on either rate control or rhythm control. Surgical ablation was first described by Cox in 1993 (the Maze procedure). This was performed in conjunction with other cardiac surgery with a successful outcome between 74% and 90% at 2–3 year follow-up. However, procedure times were long, and 6% of patients required postoperative pacing.

More recently, the creation of a similar line set using radiofrequency ablation (RFA) has been advocated for surgical ablation of atrial fibrillation during cardiac surgery for coronary disease or cardiac valve surgery. A number of studies have shown radiofrequency surgical ablation to have good success rates 6–15 months following surgery, with only one study reporting a longer term efficacy of 73% at 40 months.

This observational audit retrospectively reviews outcomes for patients who underwent surgical RFA for atrial fibrillation at Christchurch Hospital between 2001 and 2009, assessing in particular the long-term efficacy.
Methods

The sample population included all patients identified as having undergone surgical RFA for atrial fibrillation at Christchurch Hospital between the first procedure performed on 2 July 2001 and 28 January 2009. Potential patients were identified using the hospital clinical coding system; their respective clinical records were then accessed to confirm the nature of surgery and to extract relevant data.

Both electronic and hardcopy clinical records were reviewed for each patient in the sample. Notes were screened for information regarding the original operation; all electrocardiograms prior and subsequent to operation; and postoperative clinic and admission notes for comments regarding current heart rhythm. Operation date and cardiac surgery performed were noted for each patient. Patient gender, age at surgery, and relevant documented medical diagnoses, were also extracted. Preoperative left atrial dimension by echocardiography was also documented when available.

All available information pertaining to heart rhythm, from the time of operation to the present, was recorded. Electrocardiograms were interpreted by FC in the first instance, and over read by IC. Rhythm data for each patient were then grouped according to time since surgery. Results are primarily derived from patient electrocardiograms; where no electrocardiograms was available for a given timeframe, current rhythm as documented in clinical notes has been used.

All patients underwent RFA combined with surgery for coronary disease and or valvular heart disease. Initially operations were performed as described by Raman5. Radiofrequency lesions were created using a multielectrode, temperature-controlled probe. Initially the flexible, 7-electrode, temperature-controlled unipolar Cobra probe (EP Technologies, Boston Scientific Corp, San Jose, Calif.) was used. Lesion creation parameters were set at 80°C to 85°C for 2 minutes to achieve transmural ablation.

RFA was performed endocardially in the left atrium in patients undergoing mitral valve surgery, and in some of the other patients. The RFA consisted of a linear line set along the roof of the left atrium, an encircling line set around right-sided pulmonary veins, an encircling line set around left-sided pulmonary veins with connecting line set to mitral valve annulus and a connecting line set to mitral annulus from lower right pulmonary vein orifice. In addition the left atrial appendage was over sewn in a linear fashion from within.

In some of the patients undergoing cardiac surgery other than mitral valve surgery, a comparable epicardial line set was performed consisting of a linear line set along the roof of the left atrium, an encircling line set around left-sided pulmonary veins, an encircling line set around right-sided pulmonary veins, and a connecting line set toward the atrioventricular groove. In addition the base of the left atrial appendage was ligated from the outside.

Right atrial epicardial line sets were also placed consisting of a linear line set from behind the sinoatrial node approximately along the direction of the crista terminalis and curving up to the atrioventricular groove, and a connecting line set from the inferior vena caval orifice to the right atrioventricular groove low on the body of the right atrium.

In 2005 the procedure was modified and the line pattern was adjusted to left atrial line sets combined with right and left atrial appendage ablation/ligation only, without other right atrial ablation line sets. Also at this time the ablation system was changed to the Medtronic cooled tip bipolar cardioblade pen.

Results

A total of 44 patients underwent RFA between 2 July 2001 and 28 January 2009. The mean age was 66 (range 30 to 82); 18 (41%) were female and 26 (59%) male. Preoperative atrial fibrillation was persistent in 33 and paroxysmal in 10 patients. Additional preoperative atrial flutter was present in four patients, this being the sole arrhythmia in one patient.

The surgery was mitral valve surgery in 17, mitral valve surgery combined with coronary artery grafting in six, aortic valve surgery in nine, aortic valve surgery combined with coronary grafting in one, and coronary artery grafting only in nine patients. One patient each had aortic and mitral valve combined surgery and atrial
septal defect closure. Patients were routinely given amiodarone postoperatively for 6 weeks.

Postoperatively there were three deaths prior to discharge (7%), and pacemakers were required in four patients (9%). Long-term follow-up data was obtained in all surviving patients, except three patients in whom data was limited to 4–6 weeks, but were subsequently lost to follow-up. Overall patients were followed up for 0 to 102 months (45±29months, mean±SD). Two patients later underwent transcatheter ablation, one for right atrial typical and atypical atrial flutter, and one with repeat pulmonary vein isolation for atrial fibrillation.

Atrial rhythm following surgical RFA—Immediately following surgery three patients remained in atrial fibrillation. The remaining patients were in sinus rhythm, or were in paced rhythm without evidence of atrial fibrillation.

In the 38 patients with extended follow-up, 37 had one or more episodes of atrial arrhythmia; atrial flutter and fibrillation in 20 patients, atrial fibrillation only in 15 patients, and atrial flutter only in two patients. At 6 months 23 had developed persistent atrial fibrillation, six persistent atrial flutter, five were in sinus rhythm, and in four patients the rhythm could not be determined with certainty.

At last follow-up 27 patients had developed persistent atrial fibrillation and four persistent atrial flutter. Persisting long-term benefit was seen in seven patients (18%, 7/38); five patients were in stable sinus rhythm (including the patient who underwent catheter ablation for atrial flutter), one had infrequent paroxysmal atrial fibrillation, and one patient had infrequent paroxysmal atrial flutter (the patient who had subsequent catheter ablation for atrial fibrillation). None of the patients with persisting long-term benefit were on antiarrhythmic medications, and in three the preoperative atrial fibrillation was paroxysmal.

Preoperative left atrial dimension was not available for all patients. However it was available in the seven patients with long-term benefit. These patients were characterized by not having marked left atrial dilation preoperatively with a maximal left atrial dimension of 46 mm.

Discussion

In this report we document the long-term efficacy of adjuvant surgical RFA for atrial fibrillation during cardiac surgery, in a single centre with long-term follow-up. Like other series5–10 we observed good initial efficacy. However with long-term follow-up the majority of patients did not maintain sinus rhythm, with only 18% of patients considered to have long-term benefit; five patients with stable sinus rhythm, and one patient each with infrequent paroxysmal atrial fibrillation and flutter.

Our results are in contrast to the series of Sie et al which reported an efficacy of 73% at 40 months.10 We can only speculate as to the reasons for the poorer long-term efficacy in our series; possible causes include a longer follow-up period, and different patient populations and surgical techniques. Also in the Sie report success beyond 6 months was determined from clinic reports, rather than electrocardiograms, which may have overestimated the long-term maintenance of sinus rhythm.
The poorer efficacy in this series than with the Cox-Maze procedure,\(^2,3\) suggests that RFA does not replicate the effect of the cut and sew procedure, with likely recovery of tissue conduction. This was certainly observed in the two patients that subsequently underwent catheter ablation where recovery of conduction across the surgical RFA lines was observed.

Interestingly, a large proportion of patients, many of whom had no prior history of atrial flutter, were found to have at least one episode of atrial flutter (with or without atrial fibrillation also) postoperatively, suggesting the atrial flutter may have been a result of the operation. In a previous report of surgical RFA using a different line set, postoperative atrial flutter was observed in 96% of patients, due to incomplete ablation of atrial tissue and proarrhythmic gaps in the linesets.\(^1\) Therefore it is probable at least some of the postoperative atrial flutter in this series represent newly generated arrhythmia secondary to incomplete line formation from surgical RFA.

We also observed that long-term maintenance of sinus rhythm was more frequent in patients that had paroxysmal as opposed to persistent atrial fibrillation. Also patients that had long-term maintenance of sinus rhythm did not have marked left atrial dilation, but the absence of data on left atrial size in the whole group limits conclusions. The previous surgical studies did not address the predictive role of left atrial size, and only two studies included patients with paroxysmal atrial fibrillation.\(^5,12\) However in patients undergoing catheter ablation of atrial fibrillation these factors predict success.\(^13,14\)

On the other hand, the majority of patients developed recurrent persistent atrial fibrillation with long-term follow-up. This is likely due in part to the severity of their underlying cardiac disease. In addition, the poorer results that we observed with surgical RFA than previously seen with the cut and sew Cox-Maze procedure\(^2,3\) suggest that RFA does not reproduce its effects.

This is probably related to incomplete tissue ablation in the line sets as evidenced by the observation of new postoperative atrial flutter. An improvement in ablation technology that resulted in complete line sets would be likely to improve the long-term results of surgical RFA for atrial fibrillation.

**Study limitations**—This report is a retrospective chart-based review with all the inherent limitations of this approach. The duration of atrial fibrillation prior to surgery was not known. Left atrial dimension was not available on all patients. It would have been useful to determine if there was any association between duration of preoperative atrial arrhythmia and incidence of postoperative arrhythmia.

The sample size is small, and the available rhythm data incomplete with the possibility patients may have had undocumented arrhythmia. Similarly, potential confounding factors have not been addressed in the study; for example, the evolving surgical technique during the study period, other illness or cardiac events that may have precipitated atrial fibrillation or flutter.

The lack of patient perspective is also a limiting factor. Patients may have experienced atrial fibrillation or flutter that is unaccounted for in the clinical notes, and therefore not counted in the study.
More importantly, outcomes from the patient’s perspective are more likely to be centred on perceived frequency and severity of arrhythmia episodes pre- and postoperatively. If episodes of arrhythmia were felt to be less disruptive after the RFA procedure, than the procedure would likely be considered a success, regardless of how many episodes actually occurred, and vice versa.

To elucidate the potential relationships between patient and operative factors, further studies would be required. As always, the most compelling information would come from a prospective study, with a control group, and with follow-up rhythm recordings at regular intervals, over a period of years.

Conclusions

We report the long-term results following surgical RFA for atrial fibrillation as an adjunct to other cardiac surgery. Whilst the procedure was effective acutely, the recurrence of atrial fibrillation was high with long-term follow-up. Atrial flutter was commonly seen presumably in part due to the surgical RFA. At a mean of 45 months follow-up, 18% of patients had long-term benefit and were in either stable sinus rhythm, or had infrequent paroxysmal atrial flutter or fibrillation. Long-term benefit was associated with absence of marked left atrial dilation and persistent atrial fibrillation preoperatively.

Competing interests: None.

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